Hemisphere

# V104s GPS Compass

## User Guide

Part No. 875-0346-0 Rev. A1

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.


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| 6111549 | 6876920 | 7400956 | 8000381 | 8214111 | 2002244539 |
| 6397147 | 7142956 | 7429952 | 8018376 | 8217833 | 2002325645 |
| 6469663 | 7162348 | 7437230 | 8085196 | 8265826 | 2004320401 |
| 6501346 | 7277792 | 7460942 | 8102325 | 8271194 | |
| 6539303 | 7292185 | 7689354 | 8138970 | 8307535 | |
| 6549091 | 7292186 | 7808428 | 8140223 | 8311696 | |
| 6711501 | 7373231 | 7835832 | 8174437 | 8334804 | |
| 6744404 | 7388539 | 7885745 | 8184050 | RE41358 | |
| 6865465 | 7400294 | 7948769 | 8190337 | | |

Other U.S. and foreign patents pending.

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# Chapter 1: Introduction

Overview

Parts List

## Overview

The V104s™ GPS Compass is based upon Hemisphere GNSS' exclusive Crescent® and Crescent Vector™ II technology.

The V104s is a complete GPS compass and position system in a single enclosure that requires only one power/data cable connection. With its serial support and ease of installation, the V104s is the perfect solution for marine-based applications.

The V104s is an integrated system that houses the following:

- Crescent and Crescent Vector II technology
- Dual integrated GPS antennas
- Power supply
- Single axis gyro
- Tilt sensor on each axis (X and Y axes)

The gyro and tilt sensors are present to improve system performance and to provide backup heading information in the event that a GPS heading is not available due to signal blockage.

Crescent Vector II technology supports multiple RF front ends - enabling tighter coupling of measurements from separate antennas for use in heading-based products. Users will achieve excellent accuracy and stability due to Crescent's more accurate code phase measurements, improved multipath mitigation, and fewer components.

The V104s's GPS antennas are separated by 13.5 cm between their phase centers, resulting in better than 2° rms heading performance. The V104s provides heading and position updates of up to 10 Hz and delivers position accuracy of better than 1.0 m 95% of the time when using differential GPS corrections from Space Based Augmentation Systems (SBAS).

The V104s also features Hemisphere GNSS' exclusive COAST™ technology that enables Hemisphere GNSS receivers to utilize old differential GPS correction data for 40 minutes or more without significantly affecting the position quality. The V104s is less likely to be affected by differential signal outages due to signal blockages, weak signals, or interference when using COAST.

If you are new to GPS and SBAS, refer to the GPS Technical Reference for further information on these services and technologies before proceeding. The GPS Technical Reference is available from the Hemisphere GNSS website at www.hemispheregnss.com.

## Parts List

**Note:** The V104s' parts comply with IEC 60945 Section 4.4: "exposed to the weather."

The V104s GPS Compass and the power/data cable (accessory item) are the only two required components

**Table 1-1: Parts list for *Serial* version of the V104s**

| Part Name | Qty | Part Number |
|---|---|---|
| V104s GPS Compass (Serial) | 1 | 804-0114-0 |
| Screw Housing Caps | 2 | 675-0173-0 |
| Serial Cable, 5m | 1 | 051-0372-0 |
| Mounting Screws | 2 | 675-1199-000# |
| Mounting Base | 1 | 676-0035-0 |
| Mounting Nut | 1 | 676-1021-000# |
| Screw Housing Cap O-Rings | 2 | 681-1066-0 |

This User Guide is available for download from the Hemisphere GNSS website at www.hemispheregnss.com.

Chapter 1: Introduction

# Chapter 2: V104s Installation

Mounting Location
Mounting Orientation
Mounting Options
Powering the V104s
Connecting the V104s to External Devices

## Mounting Location

This section provides information on determining the best location for the V104s.

### GPS Reception

When considering where to mount the V104s, consider the following GPS reception recommendations:

- Ensure there is a clear view of the sky available to the V104s so the GPS and SBAS satellites are not masked by obstructions that may reduce system performance.
- Since the V104s computes a position based on the internal GPS antenna element, mount the V104s where you desire a position with respect to the GPS antenna (located on the side of the recessed arrow on the underside of the enclosure).
- Locate any transmitting antennas away from the V104s by at least several feet to ensure tracking performance is not compromised, giving you the best performance possible.
- Make sure there is enough cable length to route into the vessel to reach a breakout box or terminal strip.
- Do not locate the antenna where environmental conditions exceed those specified in Table B-5 on page 48.

### V104s Environmental Considerations

The V104s is designed to withstand harsh environmental conditions; however, adhere to the following limits when storing and using the V104s:

- Operating temperature: -30°C to +70°C (-22°F to +158°F).
- Storage temperature: -40°C to +85°C (-40°F to +185°F).
- Humidity: 100% non-condensing.

## VHF Interference

VHF interference from devices such as cellular phones and radio transmitters may interfere with GPS operation. For example, if installing the V104s near marine radios consider the following:

- VHF marine radio working frequencies (Channels 1 to 28 and 84 to 88) range from 156.05 to 157.40 MHz. The L1 GPS working center frequency is 1575.42 MHz. The bandwidth is +/- 2MHz to +/- 10 MHz, which is dependent on the GPS antenna and receiver design (see next page).
- VHF marine radios emit strong harmonics. The 10th harmonic of VHF radio, in some channels, falls into the GPS working frequency band, which may cause the SNR of GPS to degrade significantly.
- The radiated harmonic signal strength of different brands/models varies.
- Follow VHF radio manufacturers' recommendations on how to mount their radios and what devices to keep a safe distance away.
- Hand-held 5W VHF radios may not provide suitable filtering and may interfere with the V104s's operation if too close.

Before installing the V104s use the following diagram to ensure there are no nearby devices that may cause VHF interference.

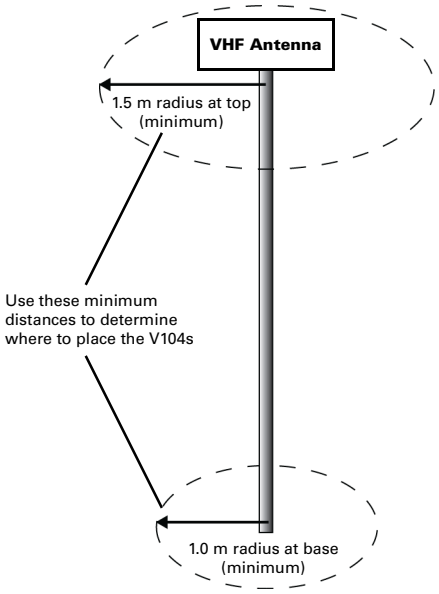



**Figure 2-1: V104s distance from nearby VHF radios**

## Mounting Orientation

The V104s outputs heading, pitch, and roll readings regardless of the orientation of the antennas. However, the relation of the antennas to the boat's axis determines whether you will need to enter a heading, pitch, or roll bias. The primary antenna is used for position. The primary and secondary antennas, working in conjunction, output heading, pitch, and roll values.

---

**Note:** Regardless of which mounting orientation you use, the V104s provides the ability to output the heave of the vessel. This output is available via the $GPHEV message. For more information on this message refer to refer to GPS Technical Reference available from the Hemisphere GNSS website at www.hemispheregnss.com.

---

***Parallel Orientation:*** The most common installation is to orient the V104s parallel to, and along the centerline of, the axis of the boat. This provides a true heading. In this orientation:

- If you use a gyrocompass, you can enter a heading bias in the V104s to calibrate the physical heading to the true heading of the vessel.
- You may need to adjust the pitch/roll output to calibrate the measurement if the Vector is not installed in a horizontal plane.

***Perpendicular Orientation:*** You can also install the antennas so they are oriented perpendicular to the centerline of the boat's axis. In this orientation:

- You will need to enter a heading bias of +90° if the primary antenna is on the starboard side of the boat and -90° if the primary antenna is on the port side of the boat.
- You will need to configure the receiver to specify the GPS antennas are measuring the roll axis using $JATT,ROLL,YES.
- You will need to enter a roll bias to properly output the pitch and roll values.
- You may need to adjust the pitch/roll output to calibrate the measurement if the Vector is not installed in a horizontal plane.

Figure 2-2 and Figure 2-3 provide mounting orientation examples.

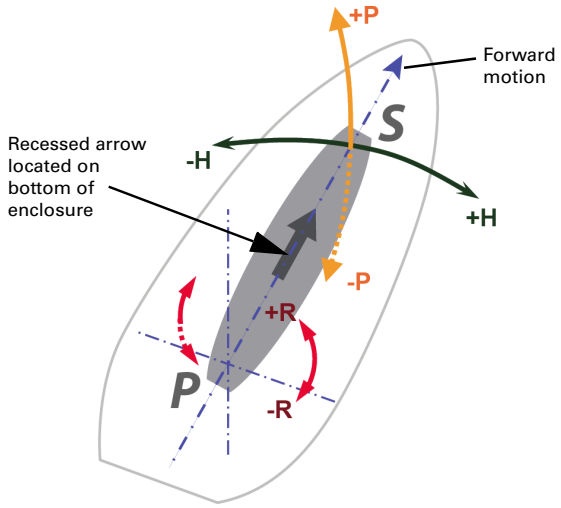



**Figure 2-2: Recommended orientation and resulting signs of HPR values**

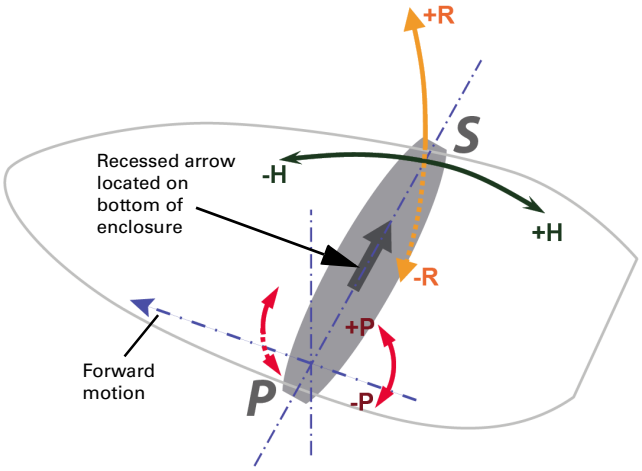



**Figure 2-3: Alternate orientation and resulting signs of HPR values**

## V104s Alignment

The top of the V104s enclosure incorporates sight design features to help you align the enclosure with respect to an important feature on your vessel.

To use the sights, center the small post on the opposite side of the enclosure from you, within the channel made in the medallion located in the center of the enclosure top as shown in Figure 2-4 and Figure 2-5. Alignment accuracy when looking through the site (Figure 2-4)and (Figure 2-5) is approximately +/- 1°.

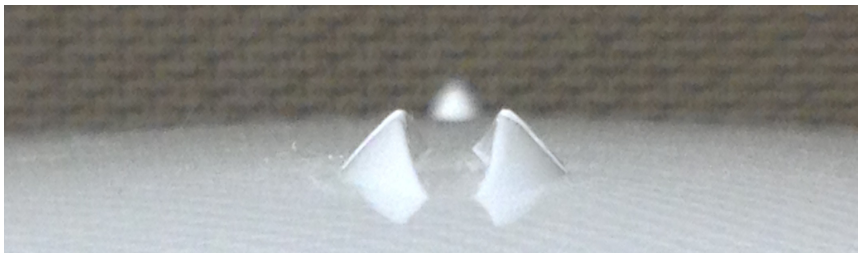


**Figure 2-4: Long site alignment channel**

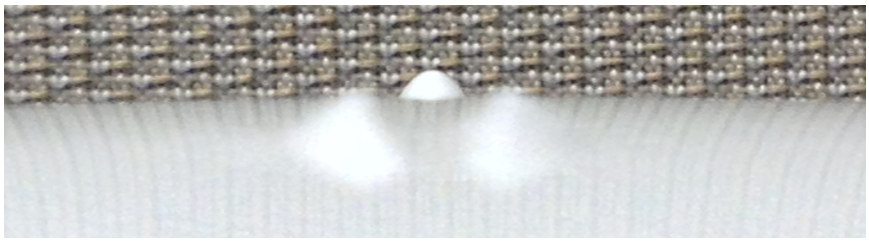


**Figure 2-5: Long sight alignment center post**

If you have another accurate source of heading data on your vessel, such as a gyrocompass, you may use its data to correct for a bias in V104s alignment within the V104s software configuration (PocketMax or VectorPC). Alternatively, you can physically adjust the heading of the V104s so that it renders the correct heading measurement; however, adding a software offset is an easier process.

## Mounting Options

The V104s allows for both pole or flush mounting. Follow directions below for detailed mounting directions.

### V104s Dimensions

Figure 2-6 illustrates the physical dimensions of the V104s.

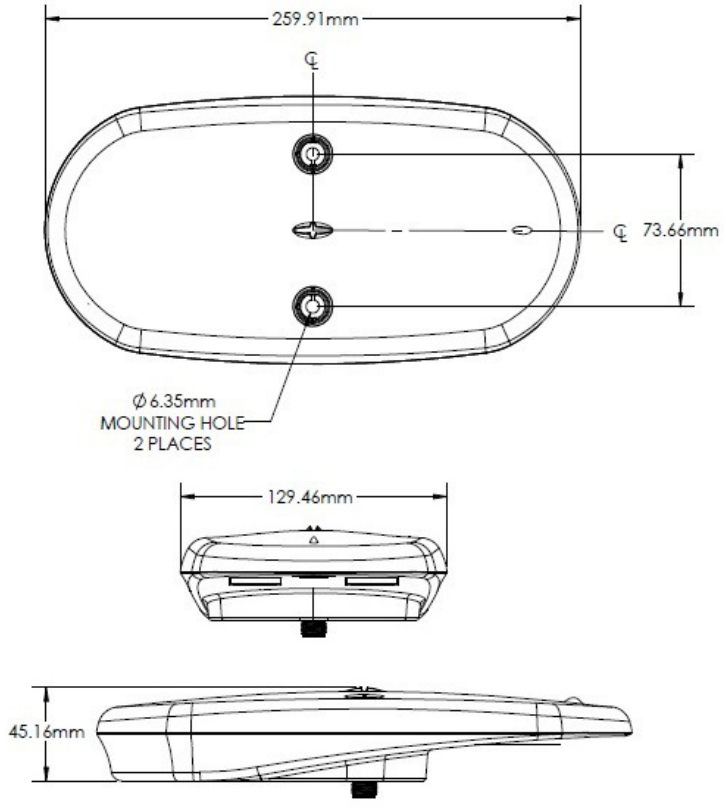
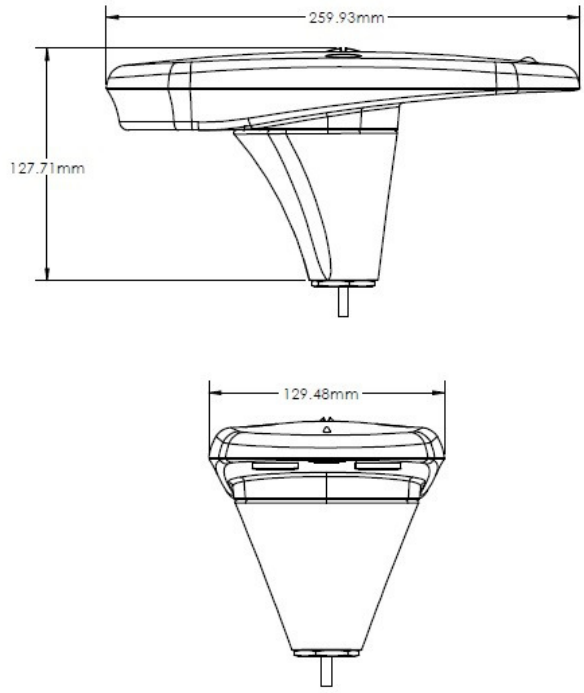



**Figure 2-6: V104s dimensions**




**V104s dimensions with adapter**

## Power/Data Cable Considerations

Before mounting the V104s consider the following regarding power/data cable routing:

- Cable must reach an appropriate power source
- Cable may connect to a data storage device, computer, or other device that accepts GPS data
- Avoid running the cable in areas of excessive heat
- Keep cable away from corrosive chemicals
- Do not run the cable through door or window jams
- Keep cable away from rotating machinery
- Do not crimp or excessively bend the cable
- Avoid placing tension on the cable
- Remove unwanted slack from the cable at the V104s end
- Secure along the cable route using plastic wraps

**⚠WARNING:** Improperly installed cable near machinery can be dangerous

## Flush Mount

The bottom of the V104s contains two holes for flush mounting the unit to a flat surface (Figure 2-7). The flat surface may be something you fabricate per your installation, an off-the-shelf item (such as a radar mounting plate), or an existing surface on your vessel.

---

**Note:** Hemisphere GNSS does not supply the mounting surface hardware. You must supply the appropriate fastening hardware required to complete the installation of the V104s.

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**Figure 2-7: Flush mounting with holes in the V104s**

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**Note**: You do not necessarily need to orient the antenna precisely as you can enter a software offset to accommodate for any bias in heading measurement due to installation.

---

**Before flush mounting the V104s**

- Determine your mounting orientation. See “Mounting Orientation” on page 9 for more information.
- Choose a location that meets the mounting location requirements.
- Using the fixed base as a template, mark and drill the mounting holes as necessary for the mounting surface.

**Flush mounting the V104s**

1. Mark the mounting hole centers and connector center on the mounting surface.
2. Place the V104s over the marks to ensure the planned hole centers align with the true hole centers (adjusting as necessary).
3. Use a center punch to mark the hole centers.
4. Drill the mounting holes to a diameter of 6.8mm (0.26 in) appropriate for the surface.
5. Drill the connector hole to a diameter of 28.6mm (1.13 in) appropriate for the surface.
6. Pull the cable through the center connector hole and attach the cable directly to the V104s, ensuring the connector clicks.
7. Place the V104s over the mounting holes and insert the mounting screws through the top of the V104s and through the mounting surface.
8. Use two M6 washers and M6 nuts to secure the V104s to the mounting plate (washers and nuts not included).

**⚠WARNING:** When installing the V104s, hand tighten only. Damage resulting from over-tightening is not covered by the warranty.

**Note:** See “V104s Dimensions” on page 12 for information on routing the power/data cable.

## Pole Mount

### Before pole mounting the V104s

- V104s provides roll measurements when mounted in any preferred orientation. If accurate roll measurements are important to your use case, we recommend mounting the V104s perpendicular to the vessel's axis. If roll measurements are less important, install the V104s parallel with the vessel's axis.
- Choose a location that meets the mounting location requirements.
- Mark and drill the mounting holes as necessary for the threaded pole.

### Pole mounting instructions for V104s (Inside Pole)

**Required tools:** 5 mm Allen key for M6 screws and adjustable wrench to tighten jam nut

1. Insert mating cable through both the jam nut and 1" (25.4mm) mounting adapter base
2. Place the jam nut on the pole followed by the 1" (25.4mm) adapter base. Hand tighten the base to the desired orientation.
3. Adjust the jam nut to secure the orientation.
4. Connect the mating end of the cable to the V104s connector located on the bottom of the unit.
5. Insert the base adapter into V104s by placing the tongue of the base into the groove of the V104s unit. When the tongue is properly seated in the groove, the rest of the base can be pressed into place to create a smooth seam between the base and V104s unit.
6. Use 5 mm Allen key to fasten two M6 screws to secure V104s onto adapter. Use 15 in-lb torque
7. Insert each o-ring onto a plastic cap
8. Install plastic cap with o-ring onto V104s unit (rectangular notch faced towards the outside)
9. Align and set the direction of V104s unit, while using the jam nut to secure the unit (hand-tighten).

---

**⚠WARNING:** Over-tightening may damage the system. This is not covered under warranty.

---

### Pole mounting instructions for V104s (Outside Pole)

**Required tools:** 5 mm Allen key for M6 screws and adjustable wrench to tighten jam nut

1. Place the jam nut on the pole followed by the 1" (25.4mm) adapter base. Hand tighten the base to the desired orientation.
2. Adjust the jam nut to secure the orientation.
3. Run the cable throughout the vessel making sure to leave enough slack to mate the NMEA 2000 cable to both the NMEA 2000 backbone and the V104s unit.
4. Run the NMEA 2000 cable through the opening in the side of the pole mounting adapter. And then connect the mating end of the cable to the V104 connector located on the bottom of the unit.
5. Insert the base adapter into V104s by placing the tongue of the base into the groove of the V104s unit. When the tongue is properly seated in the groove, the rest of the base can be pressed into place to create a smooth seam between the base and V104s unit.
6. Use 5 mm Allen key to fasten two M6 screws to secure V104s onto adapter. Use 15 in-lb torque
7. Insert each o-ring onto a plastic cap
8. Install plastic cap with o-ring onto V104s unit (rectangular notch faced towards the outside)
9. Align and set the direction of V104s unit, while using the jam nut to secure the unit (hand-tighten).

---

**⚠WARNING:** Over-tightening may damage the system. This is not covered under warranty.

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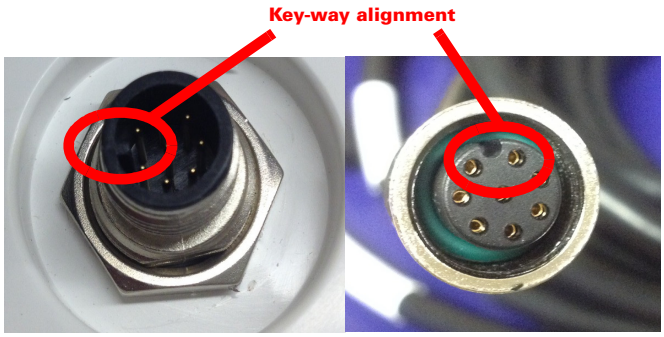
**Connecting the power/data cable**

1. Align the cable connector key-way with the V104s connector key.




2. Rotate the cable ring clockwise until it locks. The locking action is firm, but you will feel a positive “click” when it has locked.

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**Note:** See “V104s Dimensions” on page 12 for information on routing the power/data cable.

---

# Powering the V104s

## Power Considerations

For best performance use a clean and continuous power supply. The V104s power supply features reverse polarity protection but will not operate with reverse polarity.

See Table B-3 on page 47 for complete power specifications.

## Connecting to a Power Source

Before you power up the V104s you must terminate the wires of the power cable as required. There are a variety of power connectors and terminals on the market from which to choose, depending on your specific requirements.

---

**⚠WARNING:** Do not apply a voltage higher than 36 VDC. This will damage the receiver and void the warranty.

---

To interface the V104s power cable to the power source:

- Connect the red wire of the cable's power input to DC positive (+)
- Connect the black wire of the cable's power input to DC negative (-)

The V104s will start when an acceptable voltage is applied to the power leads of the extension cable.

## Electrical Isolation

The V104s's power supply is isolated from the communication lines and the PC-ABS plastic enclosure isolates the electronics mechanically from the vessel (addressing the issue of vessel hull electrolysis).

# Connecting the V104s to External Devices

## Power/Data Cable Considerations

The V104s uses a single 15 m (49 ft) cable for power and data input/output.

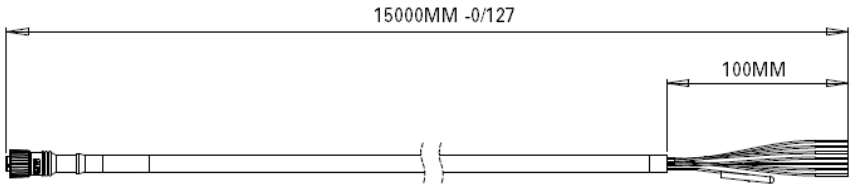


**Figure 2-8: Power/data cable, 15 m**

The receiver end of the cable is terminated with an environmentally sealed 12-pin connection while the opposite end is unterminated and requires field stripping and tinning.

Depending on the application and installation needs, you may need to shorten this cable. However, if you require a longer cable run than 15 m, you can bring the cable into a break-out box that incorporates terminal strips, within the vessel.

When lengthening the cable keep the following in mind:

- To lengthen the serial lines inside the vessel, use 20-gauge twisted pairs and minimize the additional wire length.
- When lengthening the power input leads to the V104s, ensure the additional voltage drop is small enough that your power system can continue to power the system above the minimum voltage of the system. Wire of 18-gauge or larger should also be used.
- Minimize RS-232 cable length to ensure reliable communication

## Power/Data Cable Pin-out Specifications

Figure 2-9 show the power/data cable pin-out, while Table 2-1 shows the cable's pin-out specifications.

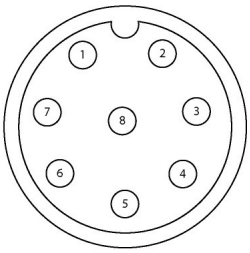


**Figure 2-9: Power/data cable pin assignment**

**Table 2-1: Power/data cable pin-out**

| Pin | Function | Wire Color |
|---|---|---|
| 1 | CH-GND | Drain |
| 1 | DGND | Brown |
| 2 | RXB | Blue |
| 3 | Power Input | Red |
| 4 | Power Ground | Black |
| 5 | TXB | Green |
| 6 | RXA | Orange |
| 7 | TXA | Purple |
| 8 | 1PPS | Yellow |

## Serial Ports

The V104s offers position and heading data via two full-duplex (bi-directional) RS-232 serial ports. In addition to outputting data, these ports are used for firmware upgrades.

### Selecting Baud Rates and Message Types

When selecting your baud rate and message types, use the following calculation to determine your baud rate for your required data throughput.

Messages * Message output rate * Message length (bytes) * bits in byte
Ex: 5 * 10Hz * 40 bytes * 10 = 20,000 bits/sec

For information on message output rates refer to GPS Technical Reference available from the Hemisphere GNSS website at www.hemispheregnss.com.

### Configuring the Ports

You may configure Port A or Port B of the GPS receiver to output any combination of data that you want. Port A can have a different configuration from Port B in terms of data message output, data rates, and the baud rate of the port. This allows you to configure the ports independently based upon your needs. For example, if you want one generalized port and one heading-only port, you can configure the ports as follows:

- Port A to have GPGGA, GPVTG, GPGSV, GPZDA, and GPHDT all output at 1 Hz over a 9600 baud rate
- Port B to have GPHDT and GPROT output at their maximum rate of 10 Hz over a 19200 baud rate

A personal computer (PC) typically uses a DB9-male connector for RS-232 serial port communications.

---

**Note:** For successful communications use the 8-N-1 protocol and set the baud rate of the V104s's serial ports to match that of the devices to which they are connected. Flow control is not supported.

---

## Default Parameters

Table 2-2 and Table 2-3 provide details on the default port settings, available baud rates, differential age, elevation mask, and default differential mode.

**Note:** Use the $JSAVE command to save changes you make to the V104s's configuration for the changes to be present in subsequent power cycles.

**Table 2-2: Default port settings**

| Port | Baud Rate | NMEA Messages | Update Rate |
|---|---|---|---|
| Port A (RS-232) | 19200 | GPGGA, GPVTG, GPGSV, GPZDA, GPHDT, GPROT | 1 Hz |
| Port B (RS-232) | 19200 | GPGGA, GPVTG, GPGSV, GPZDA, GPHDT, GPROT | 1 Hz |
| Power<br>RED (+)<br>BLK (-) | 6 - 36 VDC | | |

**Table 2-3: Additional default settings**

| Parameter | Specification |
|---|---|
| Max DGPS age (correction age) | 2700 seconds |
| Elevation mask | 5° |
| Differential mode | SBAS (WAAS/EGNOS) |

# Chapter 3: Operation

GPS Overview

V104s Overview

Common Commands and Messages

## GPS Overview

For your convenience, both the GPS and SBAS (WAAS, MSAS, GAGAN and EGNOS) operation of the V104s features automatic operational algorithms. When powered for the first time, the V104s performs a "cold start," which involves acquiring the available GPS satellites in view and the SBAS differential service.

If SBAS is not available in your area, an external source of RTCM SC-104 differential corrections may be used. If you use an external source of correction data, it must support an eight data bit, no parity, one stop bit configuration (8-N-1).

### GPS Operation

The GPS receiver is always operating, regardless of the DGPS mode of operation. The following sections describe the general operation of the V104s's internal GPS receiver.

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**Note:** Differential source and status have no impact on heading, pitch, or roll. They only have an impact on position and heave.

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#### Automatic Tracking

The V104s's internal GPS receiver automatically searches for GPS satellites, acquires the signals, and manages the navigation information required for position and tracking.

#### Receiver Performance

The V104s works by finding four or more GPS satellites in the visible sky. It uses information from the satellites to compute a position within 3 m. Since there is some error in the GPS data calculations, the V104s also tracks a differential correction. The V104s uses these corrections to improve its position accuracy to better than 1.0 m.

There are two main aspects of GPS receiver performance:

- Satellite acquisition
- Position and heading calculation

When the V104s is properly positioned, the satellites transmit coded information to the antennas on a specific frequency. This allows the receiver to calculate a range to each satellite from both antennas. GPS is essentially a timing system. The ranges are calculated by timing how long it takes for the signal to reach the GPS antenna. The GPS receiver uses a complex algorithm incorporating satellite locations and ranges to each satellite to calculate the geographic location and heading. Reception of any four or more GPS signals allows the receiver to compute three-dimensional coordinates and a valid heading.

## Differential Operation

The purpose of differential GPS (DGPS) is to remove the effects of selective availability (SA), atmospheric errors, timing errors, and satellite orbit errors, while enhancing system integrity. Autonomous position capabilities of the V104s will result in position accuracies of 3 m 95% of the time. In order to improve position quality to better than 1.0 m 95%, the V104s is able to use differential corrections received through the internal SBAS demodulator or externally-supplied RTCM corrections.

#### Automatic SBAS Tracking

The V104s automatically scans and tracks SBAS signals without the need to tune the receiver. The V104s features two-channel tracking that provides an enhanced ability to maintain a lock on an SBAS satellite when more than one satellite is in view. This redundant tracking approach results in more consistent tracking of an SBAS signal in areas where signal blockage of a satellite is possible.

## V104s Overview

The V104s provides accurate and reliable heading and position information at high update rates. To accomplish this task, the V104s uses a high performance GPS receiver and two antennas for GPS signal processing. One antenna is designated as the primary GPS antenna and the other is the secondary GPS antenna. Positions computed by the V104s are referenced to the phase center of the primary GPS antenna. Heading data references the vector formed from the primary GPS antenna phase center to the secondary GPS antenna phase center.

The heading arrow located on the bottom of the V104s enclosure defines system orientation. The arrow points in the direction the heading measurement is computed (when the antenna is installed parallel to the fore-aft line of the vessel). The secondary antenna is directly above the arrow.

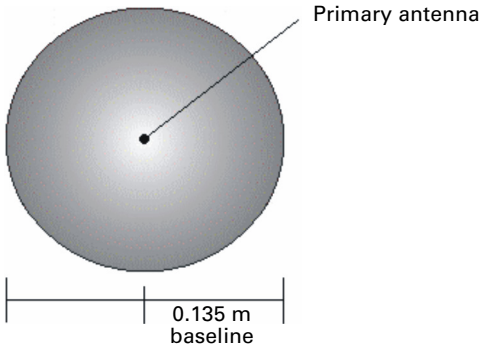


**Figure 3-1: Secondary antenna's search volume**

**Note:** The V104s moving base station algorithm only uses GPS to calculate heading. Differential corrections are not used in this calculation and will not affect heading accuracy.

## Supplemental Sensors

The V104s has an integrated gyro and two tilt sensors. The gyro and tilt sensors are enabled by default. Both supplemental sensors are mounted on the printed circuit board inside the V104s.

The sensors act to reduce the search volume, which improves heading startup and reacquisition times. This improves the reliability and accuracy of selecting the correct heading solution by eliminating other possible, erroneous solutions. Table 3-1 on page 32 provides a sensor operation summary.

**Table 3-1: Sensor operation summary**

| Feature | Normal Operation | Coasting (no GPS) |
|---|---|---|
| Heading | GPS | Gyro |
| Pitch | GPS | Inertial sensor |
| Roll | Inertial sensor | Inertial sensor |

Hemisphere GNSS' GPS Technical Reference describes the commands and methodology required to recalibrate, query, or change the sensors status.

### Tilt Aiding

The V104s' accelerometers (internal tilt sensors) are factory-calibrated and enabled by default. This improves heading solution beyond the volume associated with just a fixed antenna separation. This is because the V104s knows the approximate inclination of the secondary antenna with respect to the primary antenna. The search space defined by the tilt sensor will be reduced to a horizontal ring on the sphere's surface by reducing the search volume. This considerably decreases startup and reacquisition times (see Figure 3-2).

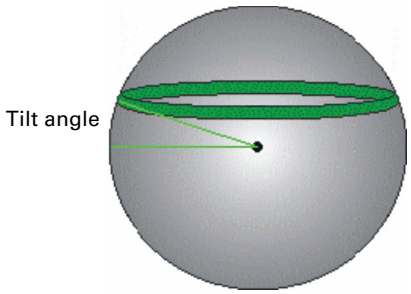


**Figure 3-2: V104s's tilt aiding**

### Gyro Aiding

The V104s' internal gyro offers several benefits. It reduces the sensor volume to shorten reacquisition times when a GPS heading is lost because the satellite signals were blocked. The gyro provides a relative change in

angle since the last computed heading, and, when used in conjunction with the tilt sensor, defines the search space as a wedge-shaped location (see Figure 3-3).

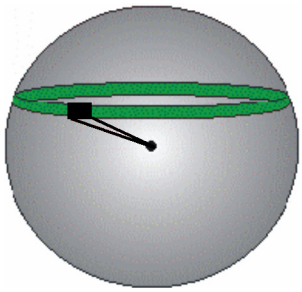

**Figure 3-3: V104s's gyro aiding**

The gyro aiding accurately smoothes the heading output and the rate of turn. It provides an accurate substitute heading for a short period depending on the roll and pitch of the vessel, ideally seeing the system through to reacquisition. The gyro provides an alternate source of heading, accurate to within 1° per minute for up to three minutes, in times of GPS loss for either antenna. If the outage lasts longer than three minutes, the gyro will have drifted too far and the V104s begins outputting null fields in the heading output messages. There is no user control over the timeout period of the gyro.

Calibration, which is set at the factory, is required for the gyro to remove latency from the heading solution as well as provide backup heading when GPS is blocked. The receiver will calibrate itself after running for a while but it may be important to follow the manual calibration instructions if you want to guarantee performance quickly after powering up the receiver.

With the gyro enabled, the gyro is also used to update the post HTAU smoothed heading output from the GPS heading computation. This means that if the HTAU value is increased while gyro aiding is enabled, there will be no lag in heading output due to vehicle maneuvers. Hemisphere GNSS' GPS Technical Reference includes information on setting an appropriate HTAU value for the application.

## Time Constants

The V104s incorporates user-configurable time constants that can provide a degree of smoothing to the heading, pitch, rate of turn (ROT), course over ground (COG), and speed measurements. You can adjust these parameters depending on the expected dynamics of the vessel. For example, increasing the time is reasonable if the vessel is very large and is not able to turn quickly or would not pitch quickly. The resulting values would have reduced "noise," resulting in consistent values with time. However, if the vessel is quick and nimble, increasing this value can create a lag in measurements. Formulas for determining the level of smoothing are located in Hemisphere GNSS' GPS Technical Reference. If you are unsure on how to set this value, it is best to be conservative and leave it at the default setting.

---

**Note:** For heading and rate of turn there is no lag once the gyro is calibrated and enabled.

---

***Heading time constant:*** Use the $JATT,HTAU command to adjust the level of responsiveness of the true heading measurement provided in the $GPHDT message. The default value of this constant is 20.0 seconds of smoothing when the gyro is enabled. The gyro is enabled by default, but can be turned off. By turning the gyro off, the equivalent default value of the heading time constant would be 0.5 seconds of smoothing. This is not automatically done and therefore you must manually enter it. Increasing the time constant increases the level of heading smoothing and increases lag.

***Pitch time constant:*** Use the $JATT,PTAU command to adjust the level of responsiveness of the pitch measurement provided in the $PSAT,HPR message. The default value of this constant is 0.5 seconds of smoothing. Increasing the time constant increases the level of pitch smoothing and increases lag.

***Rate of Turn (ROT) time constant:*** Use the $JATT,HRTAU command to adjust the level of responsiveness of the ROT measurement provided in the $GPROT message. The default value of this constant is 2.0 seconds of smoothing. Increasing the time constant increases the level of ROT smoothing.

***Course Over Ground (COG) time constant:*** Use the $JATT,COGTAU command to adjust the level of responsiveness of the COG measurement provided in the $GPVTG message. The default value of this constant is 0.0 seconds of smoothing. Increasing the time constant increases the level of COG smoothing. COG is computed using only the primary GPS antenna and its accuracy depends upon the speed of the vessel (noise is proportional to 1/speed). This value is invalid when the vessel is stationary, as tiny movements due to calculation inaccuracies are not representative of a vessel's movement.

***Speed time constant:*** Use the $JATT,SPDTAU command to adjust the level of responsiveness of the speed measurement provided in the $GPVTG message. The default value of this constant is 0.0 seconds of smoothing. Increasing the time constant increases the level of speed measurement smoothing.

## Watchdog

The watchdog is a timer that is controlled by the software that monitors if the heading is lost. The watchdog software is compliant with IEC 60945.

## Common Commands and Messages

**Note:** When selecting your baud rate and message types, use the following calculation to determine your baud rate for your required data throughput.

Messages * Message output rate * Message length (bytes) * bits in byte
Ex: 5 * 10Hz * 40 bytes * 10 = 20,000 bits/sec

For information on message output rates refer to GPS Technical Reference available from the Hemisphere GNSS website at www.hemispheregnss.com.

Table 3-2 below through Table 3-4 provide brief descriptions of common commands and messages for the V104s. Refer to the Hemisphere GNSS' GPS Technical Reference for more detailed information.

**Table 3-2: Commands**

| Command | Description |
|---|---|
| $JAGE | Specify maximum DGPS (COAST) correction age (6 to 8100 seconds) |
| $JAPP | Query or specify receiver application firmware |
| $JASC | Specify ASCII messages to output to specific ports (see ASCII messages in Table 3-3) |
| $JBAUD | Specify RS-232, RS-422 (output) communication rate |
| $JBIN | Specify binary messages to output to specific ports (see Table 3-4) |
| $JDIFF | Query or specify differential correction mode |
| $JGEO | Query or specify SBAS for current location and SBAS satellites |
| $JI | Query unit's serial number and firmware versions |
| $JOFF | Turn off all data messages |
| $JQUERY,GUIDE | Query accuracy suitability for navigation |
| $JRESET | Reset unit's configuration to firmware defaults |
| $JSAVE | Save session's configuration changes |

In Table 3-3 the Info Type value is one of the following:

- P = Position
- V = Velocity, Time
- H = Heading, Attitude
- S = Sats, Stats, Quality

**Table 3-3: NMEA 0183 and other messages**

| Message | Info Type | Description | IEC Approved Message |
|---|---|---|---|
| $GPDTM | P | Datum reference | Yes |
| $GPGGA | P | GPS position and fix data | Yes |
| $GPGLL | P | Geographic position - lat/long | Yes |
| $GPGNS | P | GNSS position and fix data | Yes |
| $GPGRS | S | GNSS range residual (RAIM) | Yes |
| $GPGSA | S | GNSS DOP and active satellites | Yes |
| $GPGST | S | GNSS pseudo range error statistics and position accuracy | Yes |
| $GPGSV | S | GNSS satellites in view | Yes |
| *$GPHDG | H | Provides magnetic deviation and variation for calculating magnetic or true heading<br>*see last bullet in Note at end of this table | Yes |
| *$GPHDM | H | Magnetic heading (based on GPS-derived heading and magnetic declination)<br>*see last bullet in Note at end of this table | No |
| *$GPHDT | H | GPS-derived true heading<br>*see last bullet in Note at end of this table | Yes |
| $GPHEV | H | Heave value (in meters) | Yes |
| $GPRMC | P | Recommended minimum specific GNSS data | Yes |
| *$GPROT | H | GPS-derived rate of turn (ROT)<br>*see last bullet in Note at end of this table | Yes |

**Table 3-3: NMEA 0183 and other messages (*continued)***

| Message | Info Type | Description | IEC Approved Message |
|---|---|---|---|
| $GPRRE | S | Range residual and estimated position error | Yes |
| $GPVTG | V | COG and ground speed | Yes |
| $GPZDA | V | Time and date | Yes |
| $PASHR | H | Time, heading, roll, and pitch data in one message | No |
| $PSAT,GBS | S | Satellite fault detection (RAIM) | Yes |
| $PSAT,HPR | H | Proprietary NMEA message that provides heading, pitch, roll, and time in single message | No |
| $PSAT,INTLT | H | Proprietary NMEA message that provides the pitch and roll measurements from the internal inclinometers (in degrees) | Yes |
| $RD1 | S | SBAS diagnostic information | Yes |
| $TSS1 | H | Heading, pitch, roll, and heave message in the commonly used TSS1 message format | No |

**Notes:**

- The GP of the message is the talker ID.
- You can change the message header for the HDG, HDM, HDT, and ROT messages to either GP or HE using the $JATT,NMEAHE command. For more information refer to GPS Technical Reference available from the Hemisphere GNSS website at www.hemispheregnss.com.
- GPGRS, GPGSA, GPGST, and GPGSV support external integrity checking. They are to be synchronized with corresponding fix data (GPGGA or GPGNS).
- For information on outputting roll, pitch, and heave data in one message refer to GPS Technical Reference available from the Hemisphere GNSS website at www.hemispheregnss.com.

**Table 3-4: Binary messages**

| $JBIN Message | Description |
|---|---|
| 1 | GPS position |
| 2 | GPS DOPs |
| 80 | SBAS |
| 93 | SBAS ephemeris data |
| 94 | Ionosphere and UTC conversion parameters |
| 95 | Satellite ephemeris data |
| 96 | Code and carrier phase |
| 97 | Processor statistics |
| 98 | Satellites and almanac |
| 99 | GPS diagnostics |

**Table 3-5: Parameters specific to $JATT command**

| Parameter | Description | Query | Specify |
|---|---|---|---|
| COGTAU | Set/query COG time constant (0.0 to 3600.0 sec) | X | X |
| CSEP | Query antenna separation | X | |
| EXACT | Enable/disable internal filter reliance on the entered antenna separation | X | X |
| FLIPBRD | Turn the flip feature on/off | X | X |
| GYROAID | Enable/disable gyro | X | X |
| HBIAS | Set/query heading bias (-180.0° to 180.0°) | X | X |
| HELP | Show the available commands for GPS heading operation and status | X | |
| HIGHMP | Set/query the high multipath setting for use in poor GPS environments | X | X |
| HRTAU | Set/query ROT time constant (0.0 to 3600.0 sec) | X | X |

**Table 3-5: Parameters specific to $JATT command (*continued)***

| Parameter | Description | Query | Specify |
|---|---|---|---|
| HTAU | Set/query heading time constant (0.0 to 3600.0 sec)<br>**Note:** Higher HTAU values combined with disabling the gyro will result in significant lag time | X | X |
| LEVEL | Enable/disable level operation | X | X |
| MSEP | Manually set or query antenna separation | X | X |
| NEGTILT | Enable/disable negative tilt | X | X |
| NMEAHE | Change the HDG, HDM, HDT, and ROT message headers between Talker IDs (GP and HE) | X | X |
| PBIAS | Set/query pitch/roll bias (-15.0° to 15.0°) | X | X |
| PTAU | Set/query pitch time constant (0.0 to 3600.0 sec) | X | X |
| ROLL | Configure for roll or pitch GPS orientation | X | X |
| SEARCH | Force a new GPS heading search | | X |
| SPDTAU | Set/query speed time constant (0.0 to 3600.0 sec) | X | X |
| SUMMARY | Display a summary of the current Crescent Vector settings | X | |
| TILTAID | Enable/disable accelerometer, pre-calibrated | X | X |
| TILTCAL | Calibrate accelerometers | | X |

# Appendix A: Troubleshooting

Table A-1 provides troubleshooting for common problems.

**Table A-1: Troubleshooting**

| Symptom | Possible Solution |
|---|---|
| Receiver fails to power | • Verify polarity of power leads<br>• Check integrity of power cable connectors<br>• Check power input voltage (6 to 36 VDC)<br>• Check current restrictions imposed by power source (minimum available should be > 1.0 A) |
| No data from V104s | • Check receiver power status to ensure the receiver is powered (an ammeter can be used for this)<br>• Verify desired messages are activated (using PocketMax, Vector PC or $JSHOW in any terminal program)<br>• Ensure the baud rate of the V104s matches that of the receiving device<br>• Check integrity and connectivity of power and data cable connections |
| Random data from V104s | • Verify the RTCM or binary messages are not being output accidentally (send a $JSHOW command)<br>• Ensure the baud rate of the V104s matches that of the remote device<br>• Potentially, the volume of data requested to be output by the V104s could be higher than the current baud rate supports (try using 19200 as the baud rate for all devices or reduce the amount of data being output) |
| No GPS lock | • Verify the V104s has a clear view of the sky<br>• Verify the lock status of GPS satellites (this can be done with PocketMax or VectorPC) |

**Table A-1: Troubleshooting (*continued)***

| Symptom | Possible Solution |
|---|---|
| No SBAS lock | • Verify the V104s has a clear view of the sky<br>• Verify the lock status of SBAS satellites (this can be done with PocketMax - monitor BER value)<br>• Set SBAS mode to automatic with the $JWAASPRN,AUTO command<br>**Note:** SBAS lock is only possible if you are in an appropriate SBAS region; currently, there is limited SBAS availability in the southern hemisphere. |
| No heading or incorrect heading value | • Check CSEP value is fairly constant without varying more than 1 cm (0.39 in)—larger variations may indicate a high multipath environment and require moving the receiver location<br>• Recalibrate the tilt sensor with $JATT,TILTCAL command if heading is calculated then lost at consistent time intervals<br>• Heading is from primary GPS antenna to secondary GPS antenna, so the arrow on the underside of the V104s should be directed to the bow side<br>• $JATT,SEARCH command forces the V104s to acquire a new heading solution (unless gyro is enabled)<br>• Enable GYROAID to provide heading for up to three minutes during GPS signal loss<br>• Enable TILTAID to reduce heading search times<br>• Monitor the number of satellites and SNR values for both antennas within PocketMax—at least four satellites should have strong SNR values<br>• Potentially, the volume of data requested to be output by the V104s could be higher than the current baud rate supports (try using 19200 as the baud rate for all devices or reduce the amount of data being output)<br>• Intermittent issues potentially caused by an incorrect HBIAS. |

**Table A-1: Troubleshooting (*continued)***

| Symptom | Possible Solution |
|---|---|
| No DGPS position in external RTCM mode | • Verify the baud rate of the RTCM input port matches the baud rate of the external source<br>• Verify the pin-out between the RTCM source and the RTCM input port (transmit from the source must go to receive of the RTCM input port and grounds must be connected)<br>• Ensure corrections are being transmitted to the correct port—using the $JDIFF,PORTB command on Port A will cause the receiver to expect the corrections to be input through Port B |

# Appendix B: Specifications

Table B-1 through Table B-5 provide the V104s's GPS sensor, communication, power, mechanical, and environmental specifications.

**Table B-1: GPS sensor specifications**

| Item | Specification |
|---|---|
| Receiver type | Vector GPS L1 Compass |
| Channels | Two 12-channel, parallel tracking<br>(Two 10-channel when tracking SBAS) |
| SBAS tracking | 2-channel, parallel tracking |
| Update rate | 10 Hz standard (position and heading) |
| Position accuracy<br>Single Point[1]<br>SBAS[2] | <br>1 m (95%)<br>3 m (95%) |
| Heading accuracy | 2° (RMS) |
| Heave accuracy | < 30 cm (RMS)[3] |
| Pitch/Roll accuracy | 2° (RMS) |
| Rate of turn | 90°/s maximum |
| Cold start | < 60 s typical (no almanac or RTC) |
| Warm start | < 20 s typical (almanac and RTC) |
| Hot start | < 1 s typical (almanac, RTC, and position) |
| Heading fix | < 10 s typical (valid position) |
| Compass safe distance | 30 cm (11.8 in)[3] |
| Maximum speed | 1,850 kph (999 kts) |
| Maximum altitude | 18,288 m (60,000 ft) |

**Table B-2: Communication specifications**

| Item | Specification |
|---|---|
| Serial ports | 2 full-duplex RS-232 |
| Baud rates | 4800, 9600, 19200, 38400, 57600, 115200 |
| Correction I/O protocol | RTCM SC-104 |
| Data I/O protocol | NMEA 0183, Crescent binary[4] |

**Table B-3: Power specifications**

| Item | Specification |
|---|---|
| Input voltage | 8 to 36 VDC |
| Power consumption | ~ 2 W nominal |
| Current consumption | 165 mA @ 12 VDC |
| Power isolation | Isolated to enclosure |
| Reverse polarity protection | Yes |

**Table B-4: Mechanical specifications**

| Item | Specification |
|---|---|
| Enclosure | UV resistant, white plastic, Geloy CR7520 (ASA) |
| Dimensions (not including mount)<br><br>Dimensions (including mount) | 25.9 L x 12.9 W x 4.5 H (cm)<br>10.2 L x 5.1 W x 1.8 H (in)<br><br>25.9 L x 12.9 W x 12.8 H (cm)<br>10.2 L x 5.1 W x 5.0 H (in) |
| Weight (not including mount)<br>Weight (including mount) | 0.42 kg (0.9 lb)<br>0.51 kg (1.1 lb) |

**Table B-5: Environmental specifications**

| Item | Specification |
|---|---|
| Operating temperature | -30°C to +70°C (-22°F to +158°F) |
| Storage temperature | -40°C to +85°C (-40°F to +185°F) |
| Water and Dust | IP69 |
| Humidity | 100% non-condensing |
| Vibration | IEC 60945 |
| EMC | CE (IEC 60945 Emissions and Immunity) FCC Part 15, Subpart B CISPR22F |

[1]Depends on multipath environment, number of satellites in view, satellite geometry, no SA, and ionospheric activity.

[2]Depends on multipath environment, number of satellites in view, SBAS coverage and satellite geometry.

[3]Based on a 40-second time constant.

[4]Hemisphere GNSS proprietary

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29.

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